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ABSTRACT

Discussed in a paper which was presented at the 1974 Annual Meeting of the American Educational Research Association are diagnostic procedures for instructional planning to be used with learning disabled elementary school children handicapped in the area of mathematics. Traditional diagnostic approaches such as intelligence tests are criticized. Offered is the engineering model of learning disabilities which provides for observation of a child's learning behaviors in an environmentally normal minisituation. Diagnosis of the child's functioning in mathematics is said to involve finding out how much the child knows in a given curriculum sequence, how the child learns new material, and how learning rate changes as a function of the child's environment. Explained is the core diagnostic procedure which examines changes in learning of five addition problems as a result of three types of feedback: acknowledgement of correct and incorrect responses, social praise for correct responses, and tangible reinforcement (tokens) for correct response. Additional modifications are given to include use of soft reprimands for incorrect responses, tokens in a response cost format, and behavior charting by the child. Advised for overcoming perceptual difficulties are modification of stimulus material such as using larger print. Suggestions are given for evaluating preferred learning modalities (visual or auditory), for determining difficulty levels through varying presentations of five addition problems, and for finding the optimum amount of over learning necessary for retention of material. Noted is the predictive relationship of the core procedure with school achievement. (MC)

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INDIVIDUALIZED DIAGNOSIS AND PROGRAM PLANNING FOR PROCESS LEARNING DEFICITS IN MATHEMATICS

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Abstract

An examination of individual pupils with process learning deficits in mathematics has led to specialized procedures for both individualized diagnosis and program planning for these mathematically handicapped pupils. The procedures examined focus on process learning models in concert with operant conditioning models as means for deriving learning problem solutions. The emphasis is on individualized approaches to diagnosis and program planning.

INDIVIDUALIZED DIAGNOSIS AND PROGRAM PLANNING FOR PROCESS LEARNING DEFICITS IN MATHEMATICS[1]

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Growing interest in elementary-school mathematics research has altered professionals to the increasing numbers of children who cannot profit from regular classroom instruction in basic mathematical processes. Whether this is the result of the "new math" (cf. Kline, 1973) or due to increased awareness of children experiencing problems is still left to considerable debate. Although considerable research has focused on curriculum development and factors related to achievement in mathematics (cf. Riedesel and Burns, 1973), it is the exceptional child that continually presents new challenges to even the most skilled and knowledgeable clinicians.

Children experiencing severe difficulties in arithmetic are frequently classified in one or more categories of the learning disabled (cf. Hammill, 1972; Vaughan and Hodges, 1973). A more refined attempt was made by Gerstmann (1957) when he described dyscalculia as an "isolated inability to perform simple or complex arithmetical operations and an impairment of orientation in the sequence of numbers and their fractions" (Alexander and Money, 1966, p. 286). Such problems as difficulty with counting or failure to recognize numbers have been labeled developmental dyscalculia (Bakwin and Bakwin, 1960; Cohn, 1968). Another writer considers dyscalculia a complicated disorder which has in its origin genetic or congenital components (Kosc, 1970; 1974).

It has been obvious that points of view represented by experts in the field yield widely varying approaches toward treatment (Bartel, 1973; Hartman, 1973; Herrick, 1973a, 1973b; Moss, 1973; Myers and Hammill, 1973; Redelheim, 1973). This may be partly due to the emphasis on a brain centered approach where far reaching speculation surrounds what area of a child's brain is the most significantly impaired. The approach advanced in this paper, however, spends little effort debating the supposed "minimal cerebral dysfunction" of such children. More generally, our concentration on accurate diagnosis is minimal. Aside from the problems inherent in such a diagnosis (cf. Birch, 1964; Severson, 1970; Sroufe and Stewart, 1973; Werry, 1968), we believe that making premature diagnostic statements has the persistent negative feature of diverting attention away from the development of effective instructional programs for exceptional children. For example, in a recent article, Kosc (1974) spent considerable effort making accurate diagnostic statements about children who represent the class of "developmental dyscalculia," but little mention was made concerning how the diagnostic approach provides helpful educational programming. We believe that such approaches have lost sight of the basic reason for assessment--to gather information that can be used to plan for more effective conditions in learning mathematics.

Traditional approaches to diagnosing children's learning disorders emphasize a "test based" assessment. Such instruments as the individually administered intelligence test or the Bender-Gestalt reputedly offer important diagnostic information which can be transformed to individualized prescriptions. However, more frequently, a battery of such tests are given to children who present learning problems and according to the discrepancy of scores when compared to a norm group, assessments are made as to the presumed deficiencies of the child, and clinical recommendations are made with regard to needed modifications in the learning process (Guthrie, 1973). Although such tests may accurately pre-

dict which children are likely to have difficulties in the future, they frequently have only weak perscriptive information with regard to problems involved in defective learning patterns and the need to define more effective teaching environments.

Recently, the most powerful critical statement made concerning the test-based assessment has come from Bersoff (1973). Essentially operating within a behavioral paradigm, he has noted that assessment frequently does not provide important decisions regarding how one might change behavior. He has also advanced an important concept labeled the "current functioning myth" (Bersoff, 1971; 1973) which closely resembles our critique of non criterion referenced approaches toward assessment. For Bersoff, the use of the term "functioning" implies that, for example, although a child may be performing at an average level (or below) on an individually administered test, statements on the child's functioning in the classroom are then made with little regard for examining important aspects of that environment. Specifically in the learning disabilities area, clinicians may make the common error that perceptual motor performance in the test situation represents current functioning in the classroom. Taking this static assessment approach does not promote an examination of factors in the environment which might change the perceptual motor functioning. As Bersoff points out, the reinforcement contingencies in the test and classroom situation may be vastly different. An approach which does not take account of this factor and avoids the systematic manipulation of it (i.e., reinforcement) in the test situation is doomed to follow the current functioning myth.

Although alternative approaches to traditional assessment may pose problems to those who have functioned comfortably in testing roles, there are alternatives which may provide important substitutes. One option surrounds the notion that rather than attempting to define learning potential within relatively constant abilities in the child, we should attempt to view learning

rate as a function of the child and the environment. This important shift in viewpoint draws the psychologist and other professionals who work with exceptional children to the realization that systematic modification of the environment can provide effective conditions for learning. The careful blending of environmental changes to meet the perceived difficulties in the child becomes the real challenge in such a behavioral approach.

The Engineering Model of Learning Disabilities

Current efforts in behavioral assessment draw from a number of techniques to gether relevant data. Generally, two approaches have come to the forefront in establishing effective and efficient modes of gaining criterion-referenced samples of behavior. Perhaps the most direct approach is to observe the child in his or her natural environment. Thus, classroom and home observation can provide important information about how aspects of these situations can be modified to improve functioning. The other, and the one which we will focus on in this paper, refers to creating miniature situations. Miniature situations, according to Bersoff (1973) "replicate functioning environments and enable the assessor to study behavior under controlled but natural like conditions when observation is not possible or desirable in real situations" (p. 897). A combination of these approaches also seems quite desirable and our model discussed elsewhere fully implements these factors (Severson, 1969, 1970; 1971; 1972; 1973a; 1973b; Severson and Kratochwill, 1973).

The use of mini situations is not a recent phenomenon. Ozer (1967) provided an evaluation protocol that samples some conditions under which a given child's learning problems may be solved. A major objective of his "Neuro-Developmental Observation" (NDO) is to simulate the process of learning within a 15 minute period (Ozer and Richardson, 1974). The NDO does not conform to a test-based approach since no score is derived in relation to a norm group and decisions do not promote a particular diagnostic category. Relating gathered

information back to classroom functioning is intrinsic to the evaluation (Ozer and Richardson, 1972). Although this approach has some criterion-referenced qualities (e.g., teaching left-right sequences), it generally does not systematically sample from the child's classroom tasks.

Similar to this analysis, we have employed an approach aimed at "criterion-referenced behavior sampling." Typically, this involves measuring the child's behavior during actual learning of material that directly relates to classroom functioning. Thus, if the child is experiencing difficulties in mathematics, one measures samples of the mathematics problem areas rather than intelligence or many of the other non-criterion-referenced tests. Drawing from the Beery (1967) model, this approach is aimed at an "assess down, teach up" strategy which allows the clinician to measure complex components of the behavior to be mastered. Since this approach has been described previously in both the reading and handwriting areas (cf. Severson, 1972; Severson and Kratochwill, 1973), it will not be discussed in detail here. However, it is emphasized that the basic approach can be duplicated in the mathematics area with equal advantage.

To provide a diagnostic model for the mathematics handicapped child, we have found that the clinician must break down the examination of the child's functioning into three parts: (a) How much the child knows in a given curriculum sequence, (b) How he/she learns new material, and (c) How learning rate changes as a function of modifications in the child's environment. Recent developments in the area of mathematics curriculums adapt quite well into the first part of the sequence (Resnick, 1967; Resnick and Wang, 1969; Resnick, Wang, and Kaplan, 1973). Resnick and her associates have developed "hierarchies of learning objectives such that mastery of objectives lower in the hierarchy (simple tasks) facilitates learning of higher objectives (more complex tasks) and ability to perform higher tasks reliability predicts ability to perform lower-level tasks" (Resnick et al., 1973, p. 679). The emphasis in these programs

is a behavioral description of number concepts such that each child's performance can be systematically plotted and examined for improvement over time. Although the work of Resnick provides important guidelines for the clinician, it is always desirable to closely examine the child's classroom curriculum scope and sequence. Nearly all such "scope and sequence" approaches will provide information on how the child is performing in comparison to within grade norms. Such grade norms can be supplied by the teacher or developed by taking a random sample of children in the classroom and constructing comparisons.

After one has determined where the child is functioning, it is desirable to move to the next phase. This is essentially the "teach up" component of the Beery model. However, we have employed two additional phases in our model which combine to provide an examination of learning and how learning can be systematically modified.

The core procedure

Although the Beery model provides a conceptual method of assessment within a basic curriculum sequence, it does not provide adequate descriptions necessary to improve criterion referenced learning. An examination of how the child learns new material in combination with providing effective changes in the child's environment composes the core diagnostic procedure. Previously labeled diagnostic teaching, the current procedure is better described as part of a "systems approach" which ultimately give promise of extending the effectiveness of manipulating the external influences on the learning process of each child.

The conceptual framework for such procedures have developed independently in a number of parallel areas (Dunn, 1968; Myers and Hammill, 1969, 1973; Quay, 1971). Dunn (1968) has noted that the child must be studied on a continuum of behavior acquired through previous experience. Both the utility of reinforcers as well as the conditions under which the child learns best are investigated (p. 12-13). Quay (1971) has extended this procedure to an examination

of stimulus, response, and reinforcement. The exceptional child is viewed as having some measurable defect in one of 41 areas which represent points of interaction of "receptive functioning," "response mechanisms" and "responsivity to reinforcement."

Recently Myers and Hammill (1973) have noted that learning disabled children must be evaluated on the basis of actual learning. Drawing on the work of Dale Bryant, they suggest that norms could be established from simple association tasks. If normal children could learn a task in ten trials, a criterion for the learning disabled child could be set somewhere below that point (p. 410). However, this procedure does not examine how important changes in the environment could improve learning rate.

In our model, the particular method of providing quality changes for the child have also led to an examination of reinforcement of learner response. Conceptualized predominantly within the framework of a functional analysis (Bijou and Peterson, 1971; Bijou and Warren, 1969), the procedure examines changes in learning as a result of three types of feedback. We have tried to remain empirical in this approach, prefering to avoid the use of such hypothetical constructs as "incentive" which characterizes Bandura's (1969) work. Furthermore, we have not stressed the refined measurement and charting techniques developed by Ogden Lindsley which currently characterize Precision Teaching (Lindsley, 1971a, 1971b).

The current model, following the original suggestions of Severson (1971), has the clinician proceed from feedback of correct and incorrect learning responses to social praise to a combination of tangible and social praise reinforcers. However, the relative efficacy of these procedures is determined by empirical verification. Following the functional analysis model, the clinician looks for behavior changes as a function of the intervention procedures employed (Bijou and Warren, 1969). Stimulus components are varied until de-

sired changes in behavior results and the best reinforcer is found for each child (Bijou and Baer, 1965). An early study (Kratochwill, 1972) and an extensive review of this area (cf. Kratochwill, 1973a) have shown us that there are unique individual variations in response to stimuli that on an a priori basis, have been labeled as reinforcers. Thus, we have frequently observed that functional definitions of rewards must take precedent over adult conceptions of what functions as a reward. Like those operating within a Precision Teaching framework, we have found "rewarding rewards," "ineffective rewards," and "punishing rewards" (Lindsley, 1971a).

Within this reinforcement sequence, it is necessary to describe areas of the math curriculum that can be employed to gather data on actual learning.

Insert Figure 1 about here

Although it is possible to begin at any point in the curriculum, we will describe a procedure which employs a list of addition problems ranging from easy combinations to more difficult sums (see Figure 1). The specific problems are taught in this basic form.

	7	6	5	4	3
Stimulus	+2	+1	+3	+4	+4
Response	9	7	8	8	7

It is assumed that we are teaching habits. When a specific stimulus is presented, a specific response should be made (Becker, 1974). However, this procedure is only one approach currently being investigated. Presumably, basic operations could be taught before or in addition to this sequence (Engelmann, 1970). For example, in the DISTAR program children are taught both rote facts (3+1=4) and how addition, subtraction, and multiplication reduce to counting operations.

The problems are usually placed on flash cards (for ease of presentation) and then presented in a random order until at least 15 combinations are found that the child does not know. These combinations should be difficult enough so that the child cannot simply progress from one answer to the next. Five unknown combinations are then randomly assigned to each of three conditions. These sums are then taught to the child in a standardized way. This approach allows us to keep records on learning rate based on the number of errors and the number of trials. Although it is desirable to take the child to criterion (for reasons that will be discussed in more detail later in the paper) some children may have difficulty in learning even one combination effectively.

The first condition employs only feedback (knowledge of results) with no intentional approval for correct responses, or disapproval for errors. In the second condition we expose another five equally difficult combinations[3] giving only neutral feedback for errors and effusive levels of social praise for correct responses. The third condition involves the use of tangible rewards (usually provided through the use of tokens as a medium of exchange). The back up rewards are something of known value to the child such as candy, a small toy, or time spent playing a game. To increase the precision of finding an effective tangible reinforcer, we have employed a "preference inventory" format following some of the recent developments in this area (c.v., Witryol, 1971).

It is frequently necessary to arrange the token schedule so that the child is given one token for each correct response or one for every two correct responses. After answering a specific combination correctly for two successive times, the contingency is modified so that the child must now get incorrect combinations correct to earn additional tokens. This procedure has been employed because some children prolong the tasks after discovering that they can earn tokens by delibertly getting some of the problems incorrect. Additionally, a bonus token may be added when the child gets all five items correct twice in a row.

In addition to measures of actual changes in learning rate, we are interested in keeping careful records of behavioral changes in the child during such a teaching sequence. Some children have difficulty with the tasks and demonstrate dramatic postural changes such as behavioral constriction, frowning, and drawing the hands up tight against the body. It is in the social praise condition that we have found dramatic changes in involvement and expressed liking for the task. It is not unusual for a child to report that the material in the social praise and tangible conditions was much easier. This combined with such behaviors as positive statements about the self give important clinical information which will assist in developing more effective learning environments.

There are many practical questions that remain to be answered in this basic core procedure and the current developments in the model do not deal with all of them effectively. For example, we do not know how the particular sequence we are using influences the performance of the child. Nor do we have refined information telling us if these tasks should be given during the same session or spread out over several days. However, the current developments in the model are moving toward a more comprehensive examination of alternative modes of functioning.

The Extended Core Procedure

Currently, we are engineering a number of alternative clinical assessments that appear promising in extending the process approach to diagnosis. Although the extended assessment strategy described below could be viewed as unrealistically extensive in a routine diagnostic workup, we believe that the approach has merit in direct transfer to instructional programming and therefore deserves consideration on that basis. Furthermore, it must be noted that the model has been generated as a formula for clinicians working with the total environment of the child and involves both a component of screening and further programming for restoration of the more severely impaired child (cf. Severson, 1972).

Thus, the description below is really subsumed in a "systems approach" where all important areas of functioning are monitored.

Response modifications

In addition to the basic procedure examining learning under feedback, social praise, and tangible reinforcement, three additional modifications have been developed. Based on the assumption that there are unique individual variations in response to reinforcers (Kratochwill, 1972; 1973a), we have extended the core procedure to include other types of response modifications. A fourth condition involves the use of five problems in the core task where correct responses are met with effusive social praise and incorrect responses are met with verbal reproof (e.g., "you could do better than this!"). The use of such "soft-reprimands" has demonstrated remarkable improvement in some disruptive children (O'Leary, Kaufman, Kass, and Drabman, 1970). Another procedure involves the use of tokens in essentially a response cost format. In this procedure it is necessary to provide the child with a specific number of tokens initially so that is not possible to "go in the hole" on the token schedule. The child is then given two tokens for a correct response, but loses a token when a response is incorrect. This procedure can be intensified on both positive and negative dimensions by praising the child for correct responses and reproving him for incorrect responses.

Both of these "negative" approaches are currently being used only as exploratory techniques.[4] We feel that the danger in the use of these procedures is not with a "negative (reproof for example), used in conjunction with praise, but rather with the two heavy reliance on negative feedback in isolation. Furthermore, the clinician should always make an attempt to develop greater effort and involvement through the use of positive feedback.

One final modification in this basic sequence involves an examination of the child's ability to chart his own behavior and how such charting affects learning rate and involvement. This approach has been use to great advantage in the area of precision teaching (cf. Jordan and Robbins, 1971; Kunzelmann, Cohen, Hulten, Martin, and Mingo, 1970; Lindsley, 1971a; 1971b) and we have found it to be an important behavioral asset in the child's repertoire.

Insert Figure 2 about here

The procedure essentially involves directing the child to chart his own learning by circling the number correct after each learning trial (see Figure 2). If the child cannot perform basic self-charting, he is taught this before the learning task takes place. Aside from the fact that this procedure provides a potent reinforcer for many children (resulting in rapid improvement in actual learning rate), it tells us if the child is capable of performing self-charting when program planning extends into the classroom and home.

Modification of stimulus material

Although a long list of causes has been advanced to explain failure to learn basic mathematics, little attention has been given to adjusting materials to the child's perceptual difficulties. Traditionally, children who have had difficulties in learning basic mathematical operations have been trained in perceptual-motor skills. This belief was based on the assumption that early learning proceeds from motor operations, to perception, and then to cognitive synthesis. With this sequence, went the belief that the child must be taught to deal with the environment, not the reverse. One of the basic assessment approaches that we advocate is to adjust the input for the child in order to help him master a basic learning sequence. For example, rather than give the child perceptual motor training, which may be of doubtful significance

(cf., Goodman and Hammill, 1973; Hammill, Goodman, and Wiederholt, 1973 for excellent critiques of this literature), it may be more efficient to modify the perceptual environment.

Systematic study in the area of visual-perception has provided evidence that this skill varies widely according to the characteristics of the visual stimulus. Since learning basic mathematics requires the child to attach number names, or meanings with printed symbols, one method of providing effective learning is to alter the characteristics of these visual stimuli. We have found encouragement for this point of view in several recent studies (Demuth, 1972; Severson, Kratochwill, and Demuth, in preparation). Demuth (1972) suggested that modifying the size of print improved the effectiveness of teaching children words in the basic core procedure. In the study, children who were identified as low on visuoperceptual skills (as measured by the Developmental Test of Visual-Motor Integration, Beery & Buktenica, 1967), learned words more efficiently (with fewer errors) using large print whereas children of average and high visuoperceptual ability did equally well with large, medium, and small print. Based on the Severson et al., study, we have found that manipulation of three dimensional symbols enhances learning rate over simple two dimensional stimulus items in preschool children. However, the effect does not appear to be as potent in older kindergarten children.

Such modifications give promise of extending modifications in the stimulus dimension to the optimal level for each child.

Alternate modes of functioning

It is of some importance to examine the child's functioning under several different conditions which closely represent actual classroom functioning. In the math area, a systematic examination of the child's ability to perform in the written mode is necessary. Drawing from the area of precision teaching (Gaasholt, 1970; Haughton, 1971a; 1971b) we have employed a task which consists

of having the child write the numbers 1 through 10, and then to repeat the series 1 through 10, for one minute. This task will give us some basic information about the number writing capabilities of the children. Directing the child to write numbers after 10 can also supplement this procedure. Based on the data reported in Haughton (1971a; 1971b) and currently being extended by us, it has been determined that an aim of writing 80 digits per minute is an important goal for basic math computation.

An extension of this procedure involves the writing of several problems and their solutions. After we find combinations that the child cannot solve, we give several problems to perform graded in difficulty level. For example, the following problems may be presented verbally: 9 + 7 = __, 21 + 72 = ___, 168 + 239 = ____. The child is told to write the problems from dictation and to complete the sums. We allow the child time to complete a problem and then provide feedback immediately after the combination is solved (or until the child says he cannot perform the operation). After three problems are attempted, suggestions are made regarding important aspects of the task. The child may be taught certain characteristics of regrouping numbers, or the cumulative property of addition. The series is usually continued and careful records are kept of trials needed to reach criterion. New combinations are introduced once the first set has been successfully solved. After several sequences of this type, we systematically return to the original problems and determine if the child has retained basic operations and solutions. If the child shows no improvement in this sequence we are sent back to an examination of more basic operations.

Up to this point we have discussed essentially a visual mode of functioning. An examination of the auditory mode is of equal importance and in fact may provide numerous insights into how the child copes with auditory demands in the classroom. In our auditory assessment sequence we may present a format in which problems are presented with the correct answer. For example, the child

is given problems he does not know in the form: 2 X 3 = 6, 4 X 4 = 16, 5 X 4 = 20. The clinician then gives the first part of the problem and the child is asked to provide the correct answer. Again, a careful record is kept of the number of trials required to master this sequence. For some children, three combinations are too difficult to hold in memory and at this point we would drop out one combination to see if the child's performance improves. It is in this sequence that we determine if the child can rehearse items and store them in short term memory. Such a strategy is of demonstrated importance when one is directing a child to practice his basic combinations in the classroom or home.

Variations in difficulty level

After a basic teaching sequence in which effective reinforcers have been found, the core procedure can be extended to an examination of how various difficulty levels contribute to the learning process. If five math combinations are too difficult for the child, two variations are used to determine the child's level of effective functioning.

The first procedure is described as the cumulative format, where only one combination (or basic item to be learned) is presented at a time. As in the earlier core sequence, five combinations are picked from an area the child does not know. They should be from the same area (e.g., addition), and consistent instructure, i.e., no part of the equation is omitted. Five flash cards might be employed and look like the following:

3	6	5	8	9
+4	+3	+7	+5	+4

Later, it is possible to change the format by introducing such combinations as:

6	5		4	8
+	+4	+6	+	+5
9		13	11	1

After the child is able to give two correct answers to a problem, the second problem is presented, together with the first. This sequence continues until all five combinations are learned. If the child misses a combination which was previously responded to correctly, the entire sequence is presented again. After mastering all five combinations, they are set aside and another series can be taught. Since rehearsal of the prior sets will be of importance, some time should be set aside for this at the end of the session. This procedure also allows the clinician to check retention over relatively short periods of time.

Another variation of this sequence directly manipulates the success-failure ratio to insure success in the child. Some children show a marked aversion to large amounts of new material introduced both during the individual sessions and during regular classroom instruction. In this procedure one should begin the task by having three combinations that the child can successfully perform. Typically, two problems can be combinations that the child cannot solve. The procedure begins by placing the three known sums in a row in full view of the child. An unknown combination is then introduced and the child is told to repeat the correct answer. One of the known combinations is then presented. After the child has made the correct answer, the new combination is presented again. Although the child almost always can function at this level, we attempt to build overlearning by continuing this process until we have gone through the three previously known combinations. After we feel that the child is truly experiencing a sense of mastery (generally, three successive correct responses on all four words insure this), the other unknown combination is introduced. The procedure then follows the same format used when the first combination was introduced, except now the first unknown combination becomes part of the known list.

Retrieval of past learning

The true complexity of the learning process is both difficult to describe and effectively monitor. If we limit an examination of the process to the cognitive level, it is necessary to determine how memory impairments contribute to the child's disability. Our interest in the memory area has been generated from both the experimental research and from the observation of individual children in our learning tasks. In the former, some research has suggested that when the degree of original learning is equated, slow and fast learners will forget at the same rate (cf. Shuell and Kepple, 1970). From individual children we have learned that even after quick mastery of material, with some degree of overlearning, some children frequently cannot retain it even over relatively short periods of time. Some recent research by the first author (Kratochwill, 1973) has reopened several questions regarding memory disabilities in children. Findings from the study led us to speculate that many children do not get effective amounts of overlearning in the classroom. Since overlearning is of demonstrated importance for retention (Vergason, 1968), we attempt to determine the optimal amount of overlearning necessary for the child to successfully retain material.

In this sequence, we assign three sets of equally difficult material to the basic core procedure keeping the quality of reinforcement the same across conditions. Each series of problems is taught to criterion, but the amount of overlearning is varied from two trials in the first condition (our regular standard condition) to 10 trials in the second, and to 20 trials in the third.

This assessment sequence is then extended by following a suggestion advanced by Myers and Hammill (1969) where material is taught at the beginning of the session (as described above) and then checked for retention at the end. We advocate the retention check but have no empirical data to suggest what the optimal retention interval should be. Currently, we are using the length of

the initial session (approximately 45 minutes). When the clinician has the opportunity to see the child several times per week, it is advantageous to measure retention of the material learned as frequently as possible. Our aim is to see how much the child retained in each of the three overlearning conditions. This can be accomplished in two ways in the math area. The first is a simple recall measure where the child is shown the stimulus part of the problem and is required to give the correct response. The second is an actual relearning of the material where the aim is to measure the degree of savings even when recall has not been evident. Such data is both helpful in telling us how much overlearning will be necessary to assist the child in classroom learning and the process used to store new material. We can also provide the teacher with this information so that she has some idea of how frequent rehearsal should be for effective learning and how systematic the programming must be for the individual child.

Prediction-Criterion Relationships in the Core Procedure

The core procedure, in addition to showing important clinical insights into individual learning patterns through stimulus and response modifications, has demonstrated important predictive relationships with school achievement (Bennin, 1973; Hollinger, 1972; Jones, 1970; Kratochwill, 1972; 1973b; Sewell, 1973). Although we have not investigated the relative efficacy of this approach in the math area, several investigations are currently under way. We anticipate that a process approach will replace some of the more global assessment devices that are currently employed in the area of mathematics (e.g., The Wide Range Achievement Test or the Peabody Individual Achievement Test). As currently designed, a relatively brief task such as adding five combinations or a "Numerical Triangle" (described in Kosc, 1974) is being employed.

Moving Toward an Integrated Approach

In summary, we have presented a considerable number of options for the diagnostic process. What must be stressed at this point is that the model is continually being refined and extended to gain a more comprehensive picture of the child's functioning. We believe that it is helpful to view the child as a person continually in the process of taking in new information, perceiving it, sorting and storing it, categorizing it, reflecting on it, and reacting in unique ways when encountering each learning situation. It is in this paradigm that a process approach to diagnosis can provide important information on program planning for the handicapped.

References

Alexander, D. and Money, J. Turner's syndrome and Gerstmann's syndrome: neuropsychological comparisons. Neuropsychologica, 1966, 4, 265-273.

Bakwin, H. and Bakwin, R. M. Clinical management of behavior disorders in children. Philadelphia: Saunders, 1960.

Bandura, A. Principles of behavior modification. Holt, Rinehart, & Winston, Inc., 1969.

Bartel, N. R. Disabled or disadvantaged: why the question? The Journal of Special Education. 1973, 4, 413-416.

Becker, W. C. Teaching concepts and operations, or how to make kids smart. In Roger Ulrich, Thomas Stachruk, and John Mabry (Eds.) Control of Human Behavior, Vol. III, 1974, pp. 299-312.

Beery, K. E. Visual-Motor Integration. Monograph. Follett Educational Corporation: Chicago, 1967.

Bennin, J. A. Classroom prediction of initial reading acquisition. Unpublished Doctoral Dissertation at the University of Wisconsin, 1973.

Bersoff, D. N. Current functioning myth; an over-looked fallacy in psychological assessment. Journal of Consulting and Clinical Psychology, 1971, 37, 391-393.

Bersoff, D. N. Silk purses into sows' ears. The decline of psychological testing and a suggestion for its redemption. American Psychologist, 1973, 28, 892-898.

Bijou, S. W., and Peterson, R. F. Psychological assessment in children: A functional analysis. In P. McReynolds (Ed.), Advances in Psychological Assessment. Vol. II, Palo Alto, California. Science & Behavior Books, 1971, pp. 63-78.

Bijou, S. W., and Warren, S. A. Objective observations in field situations for clinical assessment. Memorial volume to Harvey Digman, Eyman E. Meyers, and G. Tayan (Eds.) University of California Press, 1969.

Bijou, S. W., and Baer, D. M. Contributions from a functional analysis. In L. P. Lipsett and C. C. Spiker (Eds.), Advances in Child Development, 1965, pp. 211-231.

Birch, E. G. Brain damage in children. New York, Williams & Wilkens, 1964.

Cohn, R. Developmental dyscalculia. Pediatric Clinics of North America, 1968, 15, 3.

Coleman, E. B. Collecting a data base for a reading technology. Journal of Educational Psychology, 1970, 61, 1-23.

Demuth, D. M. Paired-associate learning rate as a function of variation in print size. Unpublished Master's Thesis at the University of Wisconsin, 1972.

Dunn, L. M. Special education for the mildly retarded - is much of it justifiable? Exceptional Children, 1968, 35, 5-22.

Engelmann, S. The effectiveness of direct verbal instruction on IQ performance and achievement in reading and arithmetic. In Roger Ulrich, Thomas Stachnik, and John Mabry (Eds.) Control of Human Behavior, Vol. III, 1974, pp. 69-84.

Gaasholt, M. Precision techniques in the management of teacher and child behavior. Exceptional Children, 1970, 37, 129-135.

Gerstmann, J. Some notes on the Gerstmann Syndrome. Neurology, 1957, 7, 866-869.

Goodman, L. and Hammill, D. The effectiveness of the Kephart-Gelman activities in developing perceptual-motor and cognitive skills. Focus on Exceptional Children, 1973, 4,

Guthrie, J. T. Models of reading and reading disability. Journal of Educational Psychology, 1973, 65, 9-18.

Hammill, D. Learning disabilities--a problem in definition. PRISE Reporter, October, 1972, No. 4 Publication of the Pennsylvania Eastern Regional Center for Special Education.

Hammill, D. Learning disabilities--a problem in definition. PRISE Reports, October, 1972, No. 4 Publication of the Pennsylvania Eastern Regional Resource Center for Special Education.

Hammill, D., Goodman, L. and Wiederholt, L. J. Visual-motor processes: what success have we had in training them? Presented at ACLD, Detroit, Michigan, March, 1973.

Hartman, R. K. Differential diagnosis: assets and liabilities. The Journal of Special Education, 1973, 4, 393-397.

Haughton, E. Aims - Growing and Sharing Something Else Kind of Thing. Behavioral Principles and the Exceptional Child, March 1971, pp. 20-39, (a).

Haughton, E. Correlation of say sounds to say words. Behaviorgrams, Jan. 21, 1971, Article 061 (b).

Herrick, M. J. Developing individualized instruction is the difference. The Journal of Special Education, 1973, 4, 417-421. (a)

Herrick, M. J. Disabled or disadvantaged: what's the difierence? The Journal of Special Education, 1973, 7, 381-386. (b)

Hollinger, P. A. The use of regular, idiomatic and nonsense words in a paired-associate format for determining general predictors of first-grade reading ability and individual learning styles. Unpublished Master's Thesis, University of Wisconsin, 1972.

Jones, M. S. Paired-associate learning as a predictor of first grade reading achievement. Unpublished Master's Thesis at the University of Wisconsin, 1970.

Kline, M. Why Johnny can't add. New York: St. Martin's Press, 1973

Kosc, L. Psychology and psychopathology of mathematical abilities. Studia psychologica. 1970, 12, 159-162.

Kosc, L. Developmental Dyscalculia. Journal of Learning Disabilities. 1974, 7, 46-59.

Kratochwill, T. R. Changes in learning rate as a function of the modification of reinforcement. Unpublished Master's Thesis, University of Wisconsin, 1972.

Kratochwill, T. R. Praise and punishment: A review of issues and applications in children's learning. Unpublished manuscript at the University of Wisconsin, 1973 (a).

Kratochwill, T. R. Process learning, retention, and stability of reinforcement effects in first grade children. Unpublished Doctoral Dissertation at the University of Wisconsin, 1973 (b).

Kunzelmann, H. (Ed.) Precision Teaching: An Initial Training Sequence. Seattle: Special Child Publications, 1970.

Lindsley, O. R. From Skinner to precision teaching: the child knows best. Behavioral Principles and the Exceptional Child, 1971, 2-11.

Lindsley, O. G. Precision teaching in perspective: An interview with Ogden R. Lindsley. Teaching Exceptional Children, 1971, 3, 114-119.

Myers, P. and Hammill, D. Deprivation or learning disability: another dilemma for special education. Journal of Special Education, 1973, 4, 409-411.

Myers, P. and Hammill, D. Methods for Learning Disorders. New York: John Wiley & Sons, Inc., 1969.

Moss, J. W. Disabled or disadvantaged: there is a difference! Journal of Special Education, 1973, 7, 387-391.

O'Leary, K. D., Kaufman, K. F., Kass, R. E. and Drabman, R. S. The effects of loud and soft reprimands on the behavior of disruptive students. Exceptional Children, 1970, 37, 145-155.

Ozer, M. N. The Face-Hand Test in children: directions and scoring. Clinical Proceedings, Children's Hospital of D.C., 1967, 23, 305-308.

Ozer, M. N., Richardson, H. B. Jr. The diagnostic evaluation of children with learning problems: a communication process. Journal of Childhood Education, 1972, 48, 244-247.

Ozer, M. N., Richardson, H. B. The diagnostic evaluation of children with learning problems: a "process" approach. Journal of Learning Disabilities, 1974, 7, 30-34.

Quay, H. C. The Facets of Educational Exceptionality: A Conceptual Framework for Assessment, Grouping, and Instruction. Psychological Services in the Schools, 1971, 166-171.

Redelheim, P. S. Learning-disabled or culturally disadvantaged: a separate piece? Journal of Special Education, 1973, 4, 399-407.

Resnick, L. B. Design of an early learning curriculum. Working Paper 16. Pittsburgh: Learning Research and Development Center. University of Pittsburgh, 1967.

Resnick, L. B. and Wang. M. C. Approaches to the validation of learning hierarchies. Proceeding of the eighteenth annual Western Regional Conference on Testing Problems. Educational Testing Service, 1969.

Resnick, L. D., Wang, M. C., and Kaplan, J. Task analysis in curriculum design: a hierarchically sequenced introductory mathematics curriculum. Journal of Applied Behavior Analysis, 1973, 6, 679-710.

Riedesel, C. A. and Burns, P. C. Research on the Teaching of Elementary School Mathematics. Second Handbook of Research on Teaching. Robert M. W. Travers, (Ed). Rand McNally & Company, Chicago, 1973, pp. 1149-1176.

Sewell, T. E. Learning potential and intelligence as cognitive predictors of achievement in first grade black children. Unpublished Doctoral Dissertation at the University of Wisconsin, 1973.

Shuell, T. J. and Keppel, M. Learning ability and retention. Journal of Educational Psychology, 1970, 61, 59-65.

Severson, R. A. Behavior therapy with learning disabled children. In Marshal B. Rosenberg (Ed.) Educational therapy, 1973, Vol. 3, 29-55 (a).

Severson, R. A. Behavior therapy with severe learning disabilities. Unpublished manuscript, Behavior Therapy Institute, Madison, Wisconsin, 1970.

Severson, R. A. Early detectors of children with potential learning disabilities; A seven-year effort. Reprinted from the Proceedings, 80th Annual Convention, APA, 1972, pp. 561-562.

Severson, R. A. The case for the classroom management consultant. Experimental Publications System, 1971, 11, MS. No. 397-36.

Severson, R. A. The Paraprofessional Handbook. Unpublished manuscript, Behavior Therapy Institute, Madison, Wisconsin, 1973 (b).

Severson, R. A. Training paraprofessionsls for intensive skill building in an early detection program. Unpublished manuscript, 1969.

Severson, R. A. and Kratochwill, T. R. Assessment of the learning disabled child: A cybernetic compensatory approach. Paper presented at the American Psychological Association, Montreal, 1973.

Severson, R. A., Kratochwill, T. R., and Demuth, D. M. Paired-associate learning rate as a function of variation in print size, dimentionality, and mediational strategy, manuscript in preparation.

Sroufe, L. D. and Stewart, M. A. Treating Children with Stimulant Drugs. The New England Journal of Medicine, 1973, 289, 407-412.

Vaughn, R. W. and Hodges, L. A statistical survey into a definition of learning disabilities: a search for acceptance. Journal of Learning Disabilities, 1973, 6, 658-664.

Vergason, G. A. Facilitation of memory in the retardate. Exceptional Children, 1968, 34, 589-596.

Werry, J. S. Studies of the hyperactive child IV. An empirical analysis of the minimal brain dysfunction syndrome. Archives of General Psychiatry, 1968, 19, 9-16.

Witryol, S. L. Incentives and learning in children. In Reese, H. W. (Ed.), Advances in Child Development and Behavior. Vol. 6. New York: Academic Press, 1971

Footnotes

1. This paper was presented by the first author as part of a paper session entitled "Mathematics Learning in Handicapped Learners" at the American Educational Research Association, Annual Meeting, Chicago, Illinois, 1974.
2. Requests for reprints should be sent to Thomas R. Kratochwill, Ph.D., Psycho-Educational Clinic, 1025 West Johnson Street, Madison, Wisconsin 53706.
3. Actually, the equal difficulty of addition combinations is an empirical question. Some of our early work suggests that certain combinations are more difficult to learn than others. Until someone duplicates the efforts of Coleman (1970) who has described a methodology for learnability of sight words, efforts remain more speculative. Hopefully, our procedure of random assignment helps to control for such factors as uneven difficulty of the material.
4. During the past year the first author has suggested these procedures to his classes of graduate students only to find that not one felt comfortable enough to impliment the procedure.

Figure Captions

Figure 1. Addition problems used in the core procedure.

Figure 2. Format employed for self-charting task.

0	1	2	3	4	5	6	7	8	9
+1	+1	+1	+1	+1	+1	+1	+1	+1	+1

0	1	2	3	4	5	6	7	8
+2	+2	+2	+2	+2	+2	+2	+2	+2

0	1	2	3	4	5	6	7
+3	+3	+3	+3	+3	+3	+3	+3

0	1	2	3	4	5	6
+4	+4	+4	+4	+4	+4	+4

0	1	2	3	4	5
+5	+5	+5	+5	+5	+5

0	1	2	3	4
+6	+6	+6	+6	+6

0	1	2	3
+7	+7	+7	+7

0	1	2
+8	+8	+8

0
+9

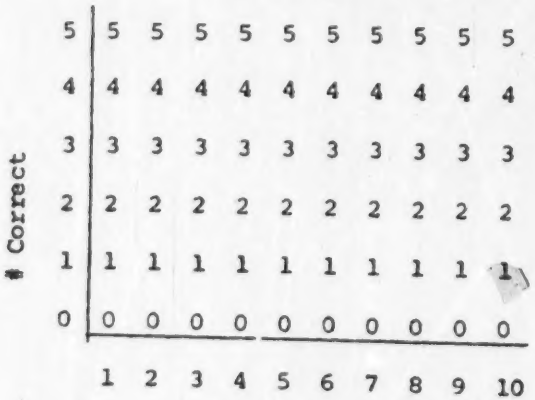
DIAGNOSTIC TEACHING

Date _____ Child _____

Teacher _____ Session # _____

_____

Feedback (FB)



Items:

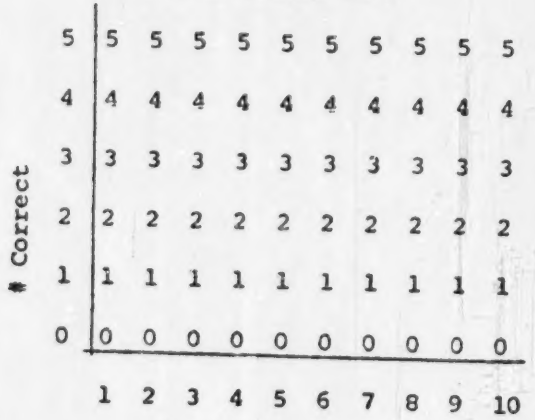
1. _____ 3. _____

2. _____ 4. _____

5. _____

Observations and Comments:

Social Praise (SP)



Items:

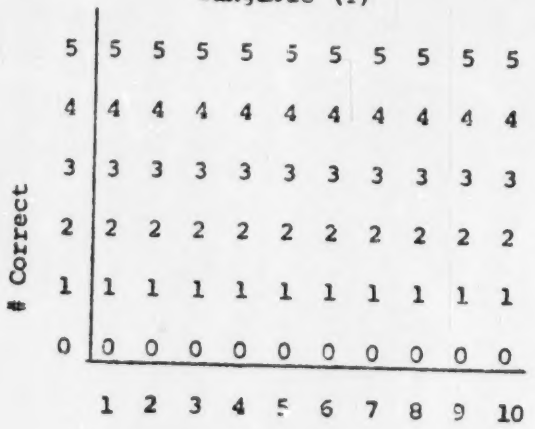
1. _____ 3. _____

2. _____ 4. _____

5. _____

Observations and Comments:

Tangible (T)



Items:

1. _____ 3. _____

2. _____ 4. _____

5. _____

Observations and Comments: